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IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

In re Application of:
David C. Tannenbaum

Confirmation No.: **5888**

Serial No.: **09/348,885**

Group Art Unit: **2671**

Filing Date: **July 1, 1999**

Examiner: **Nguyen, Phu K.**

For: **DUAL MODE DEVICE AND METHOD FOR GENERATING VECTOR CROSS PRODUCTS OR DOT PRODUCTS**

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Sir:

APPELLANT'S BRIEF PURSUANT TO 37 C.F.R. § 1.192

This brief is being filed in support of Appellant's appeal from the rejections of claims 1-20 dated August 27, 2003. Appellant filed a Notice of Appeal from the Examiner's final rejection on November 26, 2003.

This appeal brief is being submitted in triplicate, pursuant to 37 C.F.R § 1.192(a). Appellant respectfully requests that the Examiner's final rejection be reversed and that the application be remanded to the examining group for allowance.

1. REAL PARTY IN INTEREST

The real party in interest in the present appeal is Microsoft Corporation by virtue of an assignment from Silicon Graphics, Inc. to Microsoft Corporation, which was filed on December 27, 2001. David Tannenbaum (Appellant) initially assigned the application to Silicon Graphics Inc., the assignment being recorded on July 1, 1999 at Reel 010088, Frame 0352.

2. RELATED APPEALS AND INTERFERENCES

There are no other appeals or interferences known to the Appellant, the Appellant's legal representative, or the Assignee that will directly affect or be directly affected by or have a bearing on the Board's decision in the present appeal.

3. STATUS OF CLAIMS

Claims 1-3, 6-9, 11, and 18 are rejected under 35 U.S.C. § 103(a) over King (U.S. Patent No. 4,354,249) in view of Wang (U.S. Patent No. 5,187,796). Claims 4, 5, 10, 12-17, 19 and 20 are rejected under 35 U.S.C. § 103(a) over King in view of Wang and Foley ("Computer Graphics: Principles and Practice", 2nd Edition).

4. STATUS OF AMENDMENTS

No amendments have been filed subsequent to the rejection.

5. SUMMARY OF INVENTION

Rendering of realistic images is one of the main goals of graphics system designers. This rendering typically involves generating geometric models of the objects to be rendered, and applying lighting effects. Lighting models are used to more accurately provide lighting effects. Conventional lighting models typically model lighting effects, such as diffuse reflection, specular reflection, and spotlighting, by evaluating a dot product of two vectors. (application, as originally filed, page 1, line 16 – page 2, line 10).

Lighting models often include diffuse, specular, and spotlight units for evaluating the diffuse, specular, and spotlight values. Evaluating these values often requires computing the cross product of two vectors. (application, page 3, line 22 – page 4, line 5). However, conventional computer graphics systems typically evaluate cross products by using general purpose processors or dedicated cross product units. These approaches degrade performance and add substantial cost. (application, page 4, lines 16-18).

The present invention, on the other hand, is directed to a dual mode device and method for generating vector cross products or dot products in response to a signal. The dual mode device may generate either a cross product or a dot product from a first vector and a second vector. The first vector has a first set of components and the second vector has a second set of components. The device includes a dual mode controller and a dual mode unit.

The dual mode controller receives the first and second vectors and is configured to select vector components for evaluating a cross product or a dot product in response to a signal. The signal indicates whether to generate a cross product or a dot product. The dual mode unit receives the selected vector components and generates the cross product or the dot product in response to the signal.

The present invention provides a device and method that can efficiently evaluate a cross product or a dot product by using shared logic units such as multipliers and adders. Through the use of shared resources for generating the dot and cross products, the dual mode device significantly reduces the cost of the hardware needed to implement both dot product and cross product units. At the same time, providing a dedicated dual mode device for evaluating cross product or dot product enhances performance without the computational penalty associated with the overhead of a general purpose processor. (application, page 6, lines 1-24).

Figure 1A shows a block diagram of an exemplary dual mode device for generating either the cross product or the dot product from a pair of vectors A and B in accordance with the present invention. The dual mode device 100 includes a dual mode controller 102 and a dual mode unit 104. The dual mode controller 102 receives signals SELECT and COMP, and vectors A and B. The SELECT signal indicates whether to generate a cross product or a dot product. Thus, the SELECT signal indicates whether the device 100 is to operate in cross product mode or dot product mode. The dual mode controller 102 selects the components of vectors A and B needed to determine the cross product or the dot product. The dual mode unit 104 receives the vector components and SELECT signal from the dual mode controller 102 and operates in the appropriate mode to generate the cross product or dot product. (application, page 10, line 11 – page 11, line 9).

In the dual mode device, the adders and multipliers are used (shared) for determining both the cross product and the dot product. By thus sharing resources for generating cross products and dot products, the dual mode device of the present invention significantly reduces the cost of the hardware needed to implement both dot product units and cross product units. (application, page 14, lines 5-9).

6. ISSUES

A. Whether claims 1-3, 6-9, 11, and 18 patentably define over King in view of Wang.

B. Whether claims 4, 5, 10, 12-17, 19 and 20 patentably define over King in view of Wang and Foley.

7. GROUPING OF CLAIMS

Claims 1-20 stand or fall together.

8. ARGUMENT

Claims 1-3, 6-9, 11, and 18 have been rejected under 35 U.S.C § 103(a) as being unpatentable over King (U.S. Patent No. 5,187,796) in view of Wang (U.S. Patent No. 5,187,796). Claims 4, 5, 10, 12-17, 19, and 20 have been rejected under 35 U.S.C § 103(a) as being unpatentable over King in view of Wang, and further in view of Foley ("Computer Graphics: Principles and Practice", 2nd Edition).

Concerning independent claim 1, the Examiner states that:

> King discloses (column 6, lines 63-66) a unit for multiplying two N component vectors that is essentially a complex dot product device. Wang teaches (column 8, lines 8-11) a processor which is designed to efficiently perform vector/vector operations, including cross product operations. It would have been obvious to one of ordinary skill at the time of the invention to combine the dot product unit of King with the cross product processor of Wang to produce a dual-mode device which can calculate both dot product and cross product operations, because such a device would be useful in a system such as a computer graphics system where both dot and cross product operations might be needed, and it would be useful to reduce complexity by having one device which can perform both operations.
>
> The claimed feature "a plurality of shared logic units that are used to generate the cross product component and dot product" would be obvious because the calculation involving the multiply and addition operations can be implemented in an ALU of the system [and] can be used for both cross vector componentes and the dot product.
>
> It would further have been obvious to one of ordinary skill in the art at the time of the invention to include as part of the device a controller for receiving a signal indicating which of the operations to perform, since without such a controller the device would be unable to determine which operation would yield the desired output.
>
> *Rejection of August 27, 2003, at pages 2-3.*

The Examiner made similar statements regarding independent claims 11 and 18.

These rejections should be traversed for various reasons.

1. Wang teaches away from combining the references

Wang teaches a system for computing a cross product (column 8, lines 8-11) and is silent regarding computing a dot product. On the other hand, King teaches a system for computing a dot product (column 6, lines 63-66) and is silent regarding computing a cross product. Neither reference provides a teaching or motivation to combine with the other reference. As set forth below, Wang expressly teaches away from a combination with King, and, in fact, teaches away from the invention itself.

Wang's "Background of the Invention" states that "general purpose architectures sacrifice flexibility. They are not targeted to any particular class of problems" (column 3, liness 10-12). Moreover, Wang advocates using highly specialized hardware when "a class of problems with a common structural characteristic is identified, and if this class of problems encompasses enough applications, a specialized processor architecture may be justified" (column 3, lines 19-21). Thus, Wang is teaching against the use of a general purpose architecture for a particular class of problems (such as computer graphics), which is what the present invention provides. Moreover, Wang describes the desirability of the use of specialized hardware - it is just this specialization of hardware that the present invention seeks to avoid.

Further, Wang teaches against using general vector processors for vectors of fixed length and teaches the use of specialized hardware specific to vectors of shorter length. Wang teaches that the additional processor complexity required to support vectors of various length creates unacceptable overhead when performing vector operations on vectors of shorter length (column 4, lines 22-25). Thus, again, Wang is advocating the use of specialized hardware and against the general purpose, multi-tasking architecture of the present invention. Thus, one skilled in the art, when seeking to determine the cross product and dot product of vectors would look at Wang and determine that separate architectures should be implemented for each operation.

2. There is no motivation to combine King with Wang

The Examiner states that it would have been obvious to combine the inventions of Wang and King "because such a device would be useful in a system where both dot and cross product operations might be needed, and it would be useful to reduce complexity by having one device which can perform both operations." *Rejection of August 27, 2003 at page 2.*

Applicant does not dispute that presently, use of both dot product and cross products in graphics systems have become more common; however, at the time of Applicant's invention, only dot products were typically used in the graphics and simulations fields, as recognized in the application as originally filed:

> "Conventional lighting models typically model one or more lighting effects such as diffuse reflection, specular reflection, and spotlighting, each of which is typically determined by evaluating a dot product of two vectors" *(page 2, lines 8-10)*. "The diffuse light fall-off in the diffuse reflection model is typically modeled by using a dot product term N•L" (*Id. at 15-16)*. "In practice, a dot product term $(N \bullet H)^s$ is often used ...to model specular reflection" (*Id. at 22-23)*. "... a spotlight is typically computed in accordance with a basic spotlight equation ... $(S \bullet -L)^{exp}$" (*Id. at page 3, lines 7-9)*.

Hence at the time of Applicant's invention, it would not have been obvious to combine King and Wang, because dot products were typically used to model these types of lighting. There is no evidence of record indicating that those of ordinary skill would have been motivated by the references to practice the claimed invention.

Moreover, Applicant submits that King and Wang were improperly combined using hindsight reconstruction, using Applicant's claims to pick and choose among the prior art. See *In re Gorman,* 933 F.2d 982 (Fed. Cir. 1991) (noting where it was necessary to select elements of various teachings that "[I]t is impermissible, however, simply to engage in hindsight reconstruction of the claimed invention, using the applicant's structure as a template and selecting elements from references to fill the gaps.) *See In re Vaeck,* 947 F.2d 488 (Fed. Cir. 1991); *see also* MPEP 2143. Here, the Examiner's stated motivation to combine the references is that "such a device would be useful in a system such as a computer graphics system where both dot product and cross product operations might be needed" (*Rejection of August 27, 2003, at page 2*). Notably, the Examiner has not shown a suggestion to combine found in the references themselves but has merely indicated that the combination would be advantageous.

3. Neither King nor Wang discloses all of the elements of the claims

Neither King nor Wang discloses or suggests "evaluating a cross product component or a dot product in response to a first signal" or "a plurality of shared logic units that are used to generate the cross product component and the dot product" as recited by Applicant's claim

1, with analogous features being recited in claims 11 and 18. Thus, the combination of King and Wang fails to teach Applicant's invention as explicitly recited in the claims.

The examiner acknowledges that neither Wang nor King disclose or suggest use of a signal indicating whether to generate a cross or dot product, or use of shared logic units to generate the cross product component and the dot product, but asserts that both are obvious, stating:

> "The claimed feature 'a plurality of shared logic units that are used to generate the cross product component and dot product' would be obvious because the calculation involving the multiply and addition operations can be implemented in an ALU of the system [and] can be used for both cross vector components and the dot product. It would further have been obvious to one of ordinary skill in the art at the time of the invention to include as part of the device a controller for receiving a signal indicating which of the operations to perform, since without such a controller the device would be unable to determine which operation would yield the desired output." *Rejection of August 27, 2003, at page 3.*

Applicant submits that, even assuming King and Wang were combined, it would not have been obvious to "evaluat[e] a cross product component or a dot product in response to a first signal" or use "a plurality of shared logic units that are used to generate the cross product component and the dot product", as recited by Applicant's claims.

A similar situation occurred in *In re Fine,* in which the U.S. Court of Appeals overturned the Board of Patent Appeals' affirmed rejection of Fine's claims "because the PTO thought it would have been 'obvious to try' the claimed invention, an unacceptable basis for rejection." *In re Fine,* 837 F.2d at 1074. Applicant submits that determining whether a dot product or a cross product should be evaluated could be accomplished in a host of different ways, including, for example, having a routine determine the desired product by examining the inputs received by the device, and so on.

Similarly, the dot or cross product can be calculated in a dual mode unit without the use of shared logic. A device without shared logic would be desirable where parallel processing of both the cross and dot product is desired. In addition, as described above, Wang teaches away from the use of shared logic units, as they would necessarily increase the complexity of the device and add additional overhead.

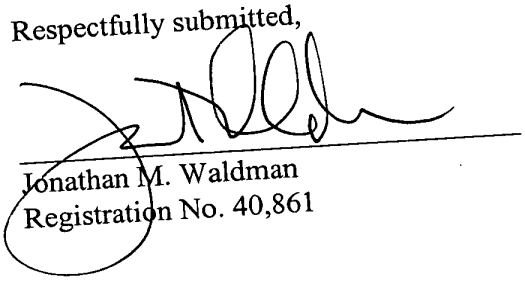
Hence, Applicant submits that use of a signal to determine whether a dot product or cross product is calculated and the use of shared logic is not obvious and respectfully requests withdrawal of the rejections of claims 1-3, 6-9, 11, and 18 under 35 U.S.C § 103(a).

Claims 4, 5, 10, 12-17, 19, and 20 have been rejected under 35 U.S.C.§ 103(a) as being unpatentable over King in view of Wang and Foley. Claims 4, 5, and 10 are dependant on claim 1, claims 12-17 are dependant on claim 11, and claims 19 and 20 are dependant on claim 18, and are patentable for at least the reasons set forth above. Foley fails to cure the deficiencies of King and Wang, because although Foley describes the use of a surface normal in determining diffuse illumination, there is no teaching or suggestion anywhere in Foley to generate a cross product or a dot product using shared logic units, as required by the claims.

CONCLUSION

For the foregoing reasons, Appellant submits that the inventions recited in claims 1-20 fully comply with the requirements of 35 U.S.C. § 103. Appellant therefore requests that this patent application be remanded to the Examiner with an instruction to both withdraw the rejections for alleged unpatentability and allow the appealed claims.

Respectfully submitted,



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APPENDIX

Claims on appeal

1. A dual mode device for generating a cross product or a dot product from a first vector and a second vector, the first vector having a first set of components and the second vector having a second set of components, the device comprising:

a dual mode controller receiving the first and second vectors, the dual mode controller being configured to select vector components for evaluating a cross product component or a dot product in response to a first signal, the first signal indicting whether to generate a cross product component or a dot product; and

a dual mode unit coupled to receive the selected vector components for generating the gross product component or the dot product in response to the first signal and comprising a plurality of shared logic units that are used to generate the cross product component and the dot product.

2. The dual mode device as recited in claim 1, wherein the dual mode unit outputs the cross product component when the first signal indicates generation of the cross product component and wherein the dual mode unit outputs the dot product when the first signal indicates generation of the dot product.

3. The dual mode device as recited in claim 1, wherein the dual mode controller receives a second signal for indicating the cross product component to be generated and selects the vector components for evaluating the cross product component in response to the second signal.

4. The dual mode device as recited in claim 1, wherein the dual mode controller selects the vector components that are different from the cross product component to be generated when the first signal indicates generation of the cross product component.

5. The dual mode device as recited in claim 1, wherein the dual mode controller changes the sign of one or more selected vector components for transmission to the dual mode unit when the first signal indicates generation of the cross product component.

6. The dual mode device as recited in claim 1, wherein the first set of components includes Ax, Ay, and Az and the second set of components includes Bx, By, and Bz, and wherein the dual mode controller selects all components of the first and second sets when the first signal indicates generation of the dot product.

7. The dual mode device as recited in claim 1, wherein the dual mode unit includes a plurality of multipliers and adders that are arranged to generate the cross product component or the dot product.

8. The dual mode device as recited in claim 7, wherein the dual mode unit uses at least one multiplier and at least one adder to generate the cross product component or the dot product.

9. The dual mode device as recited in claim 1, wherein the dual mode controller is configured to select the vector components for evaluating the cross product when the first signal indicates generation of the cross product, wherein the dual mode unit includes a plurality of sub-dual mode units for generating a plurality of cross product vector components, each sub-dual mode unit generating one cross product vector component such that the dual mode unit generates a cross product of the first and second vectors.

10. The dual mode device as recited in claim 1, wherein the dual mode unit is used in a lighting subsystem that is configured to generate diffuse light, specular light, or spotlight values.

11. The dual mode device for generating a cross product or a dot product from a first vector and a second vector, the first and second vectors having a plurality of components, the device comprising:

a dual mode controller receiving the first and second vectors, the dual mode controller being configured to select vector components for evaluating a cross product or a dot product in response to a first signal, the first signal indicating whether to generate a cross product or a dot product; and

a plurality of dual mode units coupled to receive the selected vector components for generating the cross product or the doc product in response to the first signal, each dual mode unit generating one cross product vector component of the cross product, the dual mode units generating and outputting the cross product vector components as the cross product when the select signal indicates generation of the cross product component, each dual mode unit comprising a plurality of shared logic units that are used to generate the associated cross product component and the dot product.

12. The dual mode device as recited in claim 11, wherein the dual mode controller changes the sign of one or more selected vector components for transmission to the dual mode units when the first signal indicates generation of the cross product.

13. The dual mode device as recited in claim 11, wherein the first vector includes components Ax, Ay, and Az and the second includes components Bx, By, and Bz such that the dual mode units generate the cross product by producing cross product components Cx, Cy, and Cz.

14. The dual mode device as recited in claim 12, wherein one of the dual mode units is selected to generate the dot product of the first and second vectors when the first signal indicates generation of the dot product.

15. The dual mode device as recited in claim 11, wherein the dual mode units are used in a lighting subsystem that is configured to generate a diffuse light value, a specular light value, and a spotlight value.

16. The dual mode device as recited in claim 11, wherein each of the dual mode units includes a plurality of multipliers and adders that are arranged to generate the associated cross product component or the dot product.

17. The dual mode device as recited in claim 16, wherein the dual mode unit uses at least one multiplier and at least one adder to generate the cross product component or the dot product.

18. In computer system having a graphics subsystem comprising a dual mode device, the dual mode device comprising a dual mode controller and a dual mode unit, a method for generating a cross product or a dot product from a first vector and a second vector, the first vector having a first set of components and the second vector having a second set of components, the method comprising:

receiving the first and second vectors for generating a cross product component or a dot product at the dual mode controller;

receiving the first signal indicating whether to generate a cross product component or a dot product at the dual mode controller;

selecting vector components for evaluating the cross product component or the dot product in response to the first signal;

sending the selected vector components to the dual mode unit; and

in response to the first signal and the selected vector components, generating the cross product component when the first signal indicates generation of the dot product, wherein the generating of the cross product component and the dot product is performed using a plurality of shared logic units.

19. The method as recited in claim 18, wherein the sign of one or more selected vector components are changed for evaluating the cross product component when the first signal indicates generation of the cross product component.

20. The method as recited in claim 18, wherein a plurality of cross product vector components comprising a cross product vector are generated in parallel.